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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 2475 for a patent by IRRIGATION CONTROL NETWORKS PTY LTD filed on 20 March 1998.

WITNESS my hand this Thirtieth day of April 1999

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

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PROVISIONAL SPECIFICATION

Invention Title: IMPROVED IRRIGATION CONTROL SYSTEM

The invention is described in the following statement:

Improved Irrigation Control System

Field of the invention

The invention relates to an irrigation control system for a predetermined area. In particular, scheduling and management urban irrigation of parks, gardens and sports facilities of a large city.

Description of the invention

Controllers to start and stop irrigation cycles without human intervention are well known. These controllers send an electric current (usually 24 volt alternating current in horticultural or agricultural use) to a remote solenoid valve, causing the valve to open. Valve closure is usually effected by discontinuing the supply of electric current to the solenoid of the valve whereupon the valve is caused to close.

Most of these types of controllers are able to handle a number of valves, opening and closing them in a programmed succession for programmed times on programmed days of the week. This series of sequential valve opening and closing on specified days is generally referred to as "a program" or "an irrigation program". Many of the known controllers are capable of storing and executing more than one irrigation program, which adds a degree of flexibility to what the controller may accomplish.

Basically these prior controllers fall into one of three categories as follows:

1. Relatively inexpensive controllers which are capable of executing an irrigation program. These controllers are not capable of changing the set irrigation program in any way to take account of differing water needs of plants occasioned by variations in meteorological conditions.

   Controllers of this type constitute well over 90 per cent of all irrigation controllers currently in use in Australia. Such controllers will, if the irrigation program is not regularly modified inevitably waste considerable quantities of water, since it will be programmed to supply sufficient water to serve the needs of the plant being irrigated during periods when plant demand for water is high. Thus when the same application of irrigation water continue during periods of low plant water requirement, wastage occurs.

Additionally, such controllers are incapable of responding to occurrence of rain periods unless coupled to some specialist sensor designed for the purpose. Whilst such sensors are known they tend to be either expensive (and consequently little used) or unreliable (and again little used). The potential to save water by in effect harvesting rainfall by discontinuing irrigations until that rainfall finds its way into the root-zone and is transpired by the plants, is lost unless the controller can be manually de-activated. When managing large numbers of such controllers, particularly over a wide area, it is generally not possible to manually de-activate them and re-activate them when irrigation should commence.

2. More expensive controllers which can alter the frequency and amount of irrigation, either up or down, as time passes in an effort to match applications to plant requirements. Such devices usually impute likely plant requirements by use of meteorological averages developed from examination of many years of meteorological records relating to the geographical area under consideration. This type of controller is an improvement upon the first described type of controller, but is still arbitrary and inflexible as it relies on averages which must inevitably waste water when the predicted conditions do not occur. Additionally, there can be no improvement in harvesting rainfall.

3. Expensive controllers which either accept direct input from an automatic weather stations, or accept meteorological information directly or indirectly from a remote weather station or climatic recording facility. These controllers use such information to modify a basic program so that irrigation water applications are substantially in accord with actual plant requirements. These controllers may also be activated to apply a predetermined irrigation cycle when instructed to do so by a remote software program which accepts meteorological input and maintains a water budget for the area. However, such controllers do not utilise localised rainfall measurement and consequently irrigation management depends upon rainfall information indicative of a wider area than the irrigation area. Water wastage can result. Further, these controllers must be part of a very wide

network which means that over a wide area very considerable telephony or radio costs are necessarily involved.

Another approach is described in our pending patent application no.PCT/AU97/00056 the content of which is incorporated herein. In that application, the control system is based upon a method of irrigating land which includes the steps of :

(a) measuring one or more weather conditions in a first area;

(b) measuring rainfall in a sub-area of the first area;

(c) monitoring the measurements;

(d) calculating a moisture content value for the sub-area from the measurements and a predetermined moisture loss for the sub-area; and

(e) regulating the irrigation of the sub-area.

Key to this approach is the combined use of one or more weather conditions in the first area and the rainfall in the sub area. In implementing certain forms of that invention, it has become apparent that where large numbers of sub-areas (such as parks, gardens and sports facilities) need to be managed by the system, special practical economic difficulties may arise.

If individual actual measurement is needed of a large number of sub-areas, it would be necessary to place at least one weather station including a tipping bucket (or other) type of pluviometer, in an appropriate position in each sub-area. This could be as often as 500 meters apart. However, weather stations are expensive and a very common characteristic of rainfall is that it can be extremely variable in amount and distribution even over a small area. For example, well over 1000 stations would be needed in even a small city to establish a network. Thus to produce reliable data using such pulviometers is an expensive undertaking.

Accordingly, improved and economic resolution of rainfall information over wide area is important in the management of individual sub-areas. In addressing this issue it has been found that one source of potentially useful data for this purpose is readily available.

In this respect, at present meteorological weather radars are commonly installed to cover the area of major cities. The output of these radars is a stream of data organised in the following fashion:

- Radially - each degree of rotation from 000 through to 360 is reported separately.
- Longitudinally - for each degree of rotation, data is presented as a series of rain intensity figures, typically for each kilometer along each radii. For example 095/35/9 may mean that rain intensity of "9" is falling 35 kilometers from the radar transmitter on a bearing of 095 degrees from the transmitter.

This data is analysed by a high-speed computer to produce the familiar radar screen views commonly seen on television weather reports.

Object of the invention

It is an objective of the present invention to provide an irrigation control system which ameliorates the disadvantages referred to above especially where there is a large number of sub-areas which need to be controlled.

Summary of the invention

According to one form of the invention, an irrigation control system for land is provided which includes:

(a) at least one first means to measure one or more weather conditions in a first area;

(b) at least one second means to (i) interrogate scanned rainfall data derived from a radar scanning at least the first area according to predetermined criteria and (ii) to extract data which is representative of the scanned rainfall in a sub-area of the first area;

(c) storage means to store the extracted data; and

(d) control means connected directly or indirectly to the first and second means and to the storage means, to calculate a moisture content value for the sub-area and a predetermined moisture loss value for the sub-area, and to regulate the irrigation in a sub-area.

Preferably, regulation of irrigation in the sub-area is either by initiating or preventing irrigation of the sub-area depending upon whether the moisture content value is less than or more than a predetermined moisture content value for the sub-area.

Typically, there will be one first means in each sub-area.

Typically, there will be one second means in each sub-area.

Preferably the weather conditions measured include solar radiation.

Preferably, the second means includes a sensing means, a measuring means and a data logger.

Preferably, the control means is a computer.

According to a preferred form of the invention, the irrigation control system further includes a local switch means in the sub-area to initiate or prevent irrigation in response to signals from the control means.

According to another preferred form of the invention, the local switch means in the sub-area energises or de-energises a local control means for initiating or preventing the irrigation, in response to signals from the control means.

According to another preferred form of the invention, the irrigation control system further includes interruption means to interrupt irrigation in the sub-area. Preferably, this interrupts irrigation in the sub-area in response to rainfall in the sub-area. Typically, the interruption occurs for a period of time determined by the control means.

In another independent aspect of the invention, a method of irrigating land is provided which includes the steps of :

(a) measuring one or more weather conditions in a first area;

(b) interrogating scanned rainfall data derived from a radar scanning at least the first area according to predetermined criteria and extracting data which is representative of the scanned data in a sub-area of the first area;

(c) storing the extracted data;

(d) calculating a moisture content value for the sub-area and a predetermined moisture loss for the sub-area; and

(e) regulating the irrigation of the sub-area.

Preferably the regulation of the irrigation of the sub-area is either by initiating or preventing irrigation of the sub-area depending upon whether the moisture content value is less than or more than a predetermined moisture content value for the sub-area.

Preferably, the measurement in step (a) is carried out in the same sub-area as that in which the measurement is carried out in step (b).

Preferably the method includes a further step of (f) sensing for rainfall in the sub-area during irrigation and interrupting irrigation in response to rainfall in the sub-area for a period of time controlled by the duration and amount of rainfall.

Using the system and method described above, it is possible to more accurately manage the irrigation of an area and minimise over irrigation and hence wastage of water

Description of a Practical Embodiment

The invention will now be further explained and illustrated by reference to the following practical embodiment concerning steps (b) and (c) of the control system when dealing with the radar data.

As stated above, at present meteorological weather radars are commonly installed to cover the area of major cities. In the current example this area would be seen as the first area. The output of these radars is a stream of data organised in the following fashion:

- Radially - each degree of rotation from 000 through to 360 is reported separately.
- Longitudinally - for each degree of rotation, data is presented as a series of rain intensity figures, typically for each kilometer along each radii. For example 095/35/9 may mean that rain intensity of "9" is falling 35 kilometers from the radar transmitter on a bearing of 095 degrees from the transmitter.

This radar data may be processed as follows according to one aspect of the invention.

1. Firstly a "plane geometry" program is created and initialised. This software program, on being programmed with the longitude and latitude of the radar transmitter, is able to express any longitude and latitude pair in the scanned range of the transmitter, as a radial and longitude address in terms of the data

stream emanating from the radar transmitter. This results in the production of weather radar data particular to any site (sub-area) within the coverage area (first area) of the radar. This in turn means such particular data may be identified, extracted and stored along with a time stamp by a computer.

2. The size and pattern of the network of rainfall assessments in the sub-areas to be managed is decided upon and programmed into the plane geometry software program to create the sites of a virtual rain gauge.

3. The latitude and longitude of each virtual rain gauge can now be established and accurate radar addresses for each site can be computed.

4. The radar address of each site can then be stored and an interrogating computer programmed to extract and store the data for each address so identified every time it appears in the data stream coming from the radar transmitter. If the radar bean sweeps through 360degrees every 10 seconds, then one piece of data will be stored for each virtual rain gauge site each 10 seconds.

5. This rainfall intensity data is examined for the existence of significant rain by integrating this information with time.

Consequently, by use of this technique, rainfall data for any array of points defined within the area of coverage of a weather radar can be inexpensively collected without the necessity for expensive actual rain measurement equipment. This makes possible a variety of irrigation /water management techniques which would otherwise be impossible due to lack of resolution of rainfall data.

IRRIGATION CONTROL NETWORKS PTY LTD 20 March, 1998